A.D. 1874, 14th *December*. N° 4305.

SPECIFICATION

OF

HENRY YOUNG DARRACOTT SCOTT.

TREATMENT OF SEWAGE.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY:
PUBLISHED AT THE GREAT SEAL PATENT OFFICE,
25, SOUTHAMPTON BUILDINGS, HOLBORN.
1875.

A.D. 1874, 14*th* DECEMBER. N° 4305.

Treatment of Sewage.

LETTERS PATENT to Henry Young Darracott Scott, of Ealing, in the County of Middlesex, Major General, C.B., for the Invention of "IMPROVEMENTS IN THE TREATMENT OF SEWAGE AND NIGHT SOIL."

Sealed the 23rd February 1875, and dated the 14th December 1874.

PROVISIONAL SPECIFICATION left by the said Henry Young Darracott Scott at the Office of the Commissioners of Patents, with his Petition, on the 14th December 1874.

I, HENRY YOUNG DARRACOTT SCOTT, of Ealing, in the County of Middlesex, Major General, C.B., do hereby declare the nature of the said Invention for "IMPROVEMENTS IN THE TREATMENT OF SEWAGE AND NIGHT SOIL," to be as follows :—

The object of this Invention is the treatment of sewage in such a manner as to deodorize its fertilizing constituents without degrading their value. The process is applicable to town sewage as well as to solid fœces.

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In carrying out my Invention on town sewage it is of advantage to remove as far as possible the sandy particles by means of catch pits, whilst the organic and fertilizing suspended matters are still left floating in the liquid. I allow these suspended matters to subside in suitable tanks (No. 1) of the ordinary kind, or I remove them from the liquid by a rough process of filtration; or, again, I may combine these two methods of clarifying the water. The deposit thus obtained we may call (D).

To the effluent, now to a large extent deprived of its sedimentary matters, I add milk of lime in tanks No. 2 which produce a precipitate of carbonate of lime mixed with some phosphate of lime, and also notable quantities of organic matter. By this mode of treatment my carbonate of lime precipitate being unmixed with silicious and argillaceous particles can be re-burned and re-used for the precipitation of fresh portions of sewage water, whereas by the ordinary method of procedure the deposit (D) being mixed with the lime precipitate silicates of lime, iron, and alumina are produced in the process of calcination, and thus the compound is injured as a precipitant.

After the lime precipitate has been reburned and reused several times it becomes too rich in phosphate of lime, or rather too poor in lime to be advantageously used as a precipitant, and I then apply it as I shall immediately describe. I will call the precipitate (L). It is to be observed that as the sewage water contains much carbonate of lime in solution which is precipitated by lime the precipitate largely increases in quantity at each precipitation. To the effluent from tanks No. 2 I add in tanks No. 3 an acid solution of a phosphate of iron, of lime, or of alumina, which unites with the lime left in solution in the last operation, and thus there is produced a precipitate consisting of a phosphate of one of the above-mentioned oxides, together with notable quantities of organic matter. The effluent is left in a bright condition by this process, and is then fit to be run into streams of magnitude as compared with the volume of the sewage; or it can be readily and completely cleansed by a process of intermittent downward filtration. By following the above plan I obtain my precipitated phosphate of lime in a very valuable condition.

In the phosphate processes as ordinarily employed the carbonate of lime (which is here separately precipitated) is mixed up with the

phosphate precipitate and degrades its value, often constituting 50 per cent. of the solid matters obtained. I may call this phosphate precipitate (P).

I will now return to the deposit (D). This compound, if an attempt were made to deal with it without deodorization, would prove very offensive. I therefore, either whilst still in the depositing tanks or while it is being removed from them, add a sufficient quantity of milk of lime (prepared from (L)), and of acid solution, of a phosphate of iron, or of lime, or of alumina, to deprive it of noxious smell, and I appertain the deodorants so as to leave the mixture slightly acid. I then mix the precipitate (P) with (D), and remove the excess of water in any convenient manner. In this manner I obtain a saleable and valuable manure.

If the effluent is to be used in irrigation I may omit the processes in tanks (2) and (3), and then I use ordinary lime for the deodorization of (D) in lieu of the phosphatic lime (L).

It is manifest that the three compounds I obtain may be sold separately. The compound (D) for instance is very valuable as a desiccator in the manufacture of high class superphosphates. The compound (L) again is a very valuable phosphatic lime in cases in which limeing the soil is resorted to, and the precipitate (P) is in itself a valuable manure, and may, by the addition of acid, be converted into a high class superphosphate.

In cases in which it is difficult to obtain a market for (D) where (D) is alone produced, or when lime precipitation must be employed and neither (D) nor (L) can be dispensed of readily, I vary the mode of procedure. I then use lime alone for the deodorization of (D), and I may also use some milk of lime to produce more rapid deposition of the suspended matters; but I keep this precipitant as low in quantity as possible. My object now is to distil off the nitrogen as ammonia, and to use the residue as a precipitant for the effluent from (D). To enable this to be done I add a considerable quantity of lime to (D), and the ammonia distilled off, I pass into an acid solution in the ordinary manner in order to fix it. The salt of ammonia thus obtained may be used to fortify the precipitate (P), or in any other manner. The residue after having been used in the precipitation of the effluent from (D) may be converted into a cement by a well-known process, or it may be

subjected to calcination to form a cement without further treatment as a precipitant.

In applying my process to solid fœces or night soil I separate the liquids as far as convenient and then add lime and an acid solution of a phosphate of iron, lime, or alumina to produce deodorization, and I find that I can effect this when the lime is added in the proportion of about $\frac{1}{10}$ of the weight of the wet night soil. I leave the compound very slightly acid, and then remove the excess of water by spontaneous evaporation, or by heat.

I may use charcoal in conjunction with the above deodorants either after the fœcal matters have been conveyed to the manure manufactory, or in the habitations of the people; but as my object is to produce concentrated manures (for these alone command a market) I keep the quantity of charcoal used as low as possible, unless it be of that kind which is used by sugar refiners, and which has itself a high fertilizing value. The compound obtained by this process may manifestly be subjected to distillation, and the char obtained be employed in the deodorization of fresh quantities of fœcal matters.

For the more perfect recovery of the nitrogen I may employ excess of lime, as in the case of the deposit (D).

Although it is desirable to add excess of lime to the deposit (D) when the object is the recovery of the whole of the nitrogen as a salt of ammonia, I sometimes find it advisable to neutralize the excess of lime with phosphoric acid or soluble phosphate for the sake of preparing from the deposit a substitute for animal charcoal; but under such treatment the yield of ammonia is smaller. I may also produce a substitute for animal charcoal by charing the precipitate (P).

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Henry Young Darracott Scott in the Great Seal Patent Office on the 14th June 1875.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, HENRY YOUNG DARRACOTT SCOTT, of Ealing, in the County of Middlesex, Major General, C.B., send greeting.

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WHEREAS Her most Excellent Majesty Queen Victoria by Her Letters Patent, bearing date the Fourteenth day of December, in the year of our Lord One thousand eight hundred and seventy-four, in the thirty-eighth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Henry Young Darracott Scott, Her special licence that I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, or such others as I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN THE TREATMENT OF SEWAGE AND NIGHT SOIL," upon the condition (amongst others) that I, the said Henry Young Darracott Scott, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Henry Young Darracott Scott, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being had to the Drawing hereunto annexed, and to the letters and figures marked thereon (that is to say):—

The principal part of this Invention is the treatment of sewage in such a manner as to deodorize its fertilizing constituents without degrading their value.

In carrying out my Invention it is of advantage to remove (as far as possible) the sandy particles from the liquid sewage by means of catch pits, whilst the organic and fertilizing suspended matters are still left floating in the liquid. I allow these suspended matters to subside in suitable tanks (No. 1) of the ordinary kind, or I remove them from the liquid by a rough process of filtration, or again I may combine these two

methods of clarifying the water. The deposit thus obtained we may call (D), and the manipulations to which I subject it are best performed when the solids are mixed with about ninety per cent. and upwards of the liquid, that is to say, when the mixture is of the consistence of what may be termed a thin slip.

To the effluent from tank (No. 1) now (to a large extent) deprived of its sedimentary matters I add milk of lime in tanks (No. 2) which produces a precipitate of carbonate of lime mixed with some silicate and phosphate of lime, and also notable quantities of organic matter. By this mode of treatment my carbonate of lime precipitate being unmixed with suspended siliceous and argillaceous particles can be calcined and reused for the precipitation of fresh portions of sewage water, whereas by the ordinary method of procedure, the deposit (D) being mixed with the lime precipitate, large quantities of silicates of lime, iron, and alumina are produced in the process of calcination, and thus the compound is injured as a precipitant.

After the lime precipitate has been reburned and reused several times it becomes too rich in silicate and phosphate of lime or rather too poor in lime to be advantageously used as a precipitant, and I then apply it as I shall immediately describe:—We will call the precipitate (L). It is to be observed that as the sewage water contains much carbonate of lime in solution, which can nearly all be precipitated by lime, the precipitate can be increased in quantity at each precipitation. The employment of the precipitate (L) for the manufacture of cement, as specified in my Patent, dated Twenty-sixth August, One thousand eight hundred and seventy-one, it is unnecessary to describe. Clay may be added with the milk of lime as there stated in the proportion required to give the best results in the production of cement. To the effluent from tanks (No. 2) I add in tanks, No. 3, by preference an acid solution of a phosphate of iron, of lime, or of alumina, which unites with the lime left in solution in the last operation, and thus there is produced a precipitate consisting of a phosphate of one of the above-mentioned oxides, together with notable quantities of organic matter. The effluent is left in a bright condition by this process and is then fit to be run into streams of magnitude as compared with the volume of the sewage, or it can be readily and completely cleansed by a process of intermittent downward filtra-

tion. By following the above plan I obtain a precipitated phosphate of lime in a very valuable condition.

In the phosphate processes, as ordinarily employed, the carbonate of lime (which is here nearly all separately precipitated) is mixed up with the phosphate precipitate, and degrades its value, often constituting fifty per cent. of the solid matters obtained; I may call this phosphate precipitate (P).

With the view of ridding the phosphate precipitate as far as possible of carbonic acid (which is still carried down with the phosphate as carbonate of lime in small quantities, notwithstanding the previous limeing process which retains some of it in solution) I make use of magnesia, or a salt of magnesia, in conjunction with the acid phosphate, and by this means the precipitate is almost entirely freed from the presence of carbonates.

In lieu of employing a soluble phosphate for this last precipitation I sometimes use a soluble salt of iron or alumina, but such precipitates having no further manurial value than what is due to the nitrogenous matters carried down with them I only employ them in cases in which there is no sale for phosphate manures. The precipitate may however be subjected to distillation so as to recover the nitrogen, and the mineral matters may be redissolved in acid to be employed again, or the charred compound may be used as a deodorizer or decolorizer.

Let us now return to the deposit D. This compound if an attempt were made to deal with it without deodorization would prove very offensive. I therefore operate upon it in the following manner either whilst it is in the depositing tanks or as it is being removed from them:—In this state it still contains ninety-two parts by weight of water to eight parts by weight of solid matter, though considerable latitude can be taken as to the proportion of water, and the process answers perfectly with sludge in the condition in which it is usually pumped from depositing tanks. I therefore add a sufficient quantity of milk of lime prepared from (L), and a sufficiency of acid solution (by preference of a phosphate) of iron or of lime, or of alumina, so as to neutralize the lime, or nearly so. When the compound will part with no more water by drainage more acid may be added so as to leave the mixture slightly acid. It is not however essential that this point should

be attained, for I find in practice that the sludge may exhibit a considerable degree of alkalinity without any notable loss of ammonia taking place in drying. When dry it is reduced to a powder and is ready for use as manure. By proceeding in this manner I attain several important objects,—

Firstly. I obtain the sedimentary matters almost without admixture with carbonate of lime.

Secondly. I render them inoffensive.

Thirdly. The means employed for rendering them inoffensive add to their fertilizing value.

Fourthly. I so far change the physical texture of the sludge that a remarkable facility in parting with the water it contains is substituted for strong retentiveness of that element. The addition of lime alone is not sufficient for this object. Alkalinity increases rather than diminishes the retentive properties of the sludge for water; it is only on the neutralization of the lime by an acid which will yield a mineral and (probably) crystalline precipitate that the drainage becomes easy.

I find that I can obtain facility of drainage by using sulphuric acid in lieu of a phosphate made soluble by sulphuric or hydrochloric acid, but it will be evident that the sulphuric acid may be used to more advantage when it is employed in bringing into solution phosphoric acid (whereby the value of the latter is greatly increased). I then use this solution in neutralizing the lime employed in deodorization.

It is generally advantageous for small works to make use of high class soluble superphosphates in lieu of a solution for neutralizing the lime, as this avoids the necessity of chemical manipulation on the spot. I mix the superphosphates with water before adding it to the limed sludge.

If the sludge is to be dried by mechanical appliances this phosphate precipitate for the reasons already given will be found to be of great assistance, but if it be intended to dry the sludge by settlement and spontaneous evaporation (combined or not with drainage) the time which elapses is sufficiently long to allow a second decomposition to set up unless a considerable amount of lime is used. In such cases I find one bushel of lime and upwards for the sludge deposited in twenty-four

hours from the sewage of five thousand gives satisfactory results when conditions are favorable for drying. Where gas lime can be obtained this also may be used as the deodorant, but it should be used in larger quantity. It is best to grind it to a slip, but it can also be used as supplied.

If the sludge is to be dried quickly by machinery, such as wringers or presses, a very small proportion of lime and acid is necessary for deodorization, but the facility of expressing the water increases rapidly with the amount of precipitated phosphate produced amongst the fibres of the sludge. Excellent results are obtained when the dry compound contains from eight to ten per cent. of tribasic phosphate of lime. It is best to add the lime before the phosphate solution. I mix the precipitate (P) with (D) before drying, and then remove the excess of water in any convenient manner. In this manner I obtain from sludge a saleable and valuable manure.

I am well aware that both lime and phosphate of lime, magnesia, alumina, and iron have been used for the deodorization and precipitation of town sewage. The novelty of this part of my process therefore consists not in the use of these materials, but in their application to the muddy slip or sludge which remains after the greater part of the liquid has been removed. Ordinary town sewage contains in dry weather from five to fifty grains of suspended matters per gallon, or from one thousand four hundred to fourteen thousand parts of liquid for each part of solid. In my process the liquid is reduced before the application of chemicals to ten or twenty parts of liquid to one part of solid, and by this means the deposition of carbonate of lime, which adulterates the fertilizing value of the suspended matters, is reduced to a minimum. Other deodorants may be used in conjunction with the above, such as charcoal, or carbolic acid or soot.

If the effluent is to be used for irrigation I may omit the processes in tanks (2) and (3), and then I use ordinary lime for the deodorization of (D) in lieu of the phosphatic lime (L). I may also employ the processes in tanks (1) and (2), and omit that in tank (3).

It is manifest that the whole of the three compounds obtained may be dealt with separately in the market. The compound (D) (for instance) is very valuable as a desiccator in the manufacture of high class superphosphates. The compound (L) is again a valuable phosphatic lime in

cases in which limeing the soil is resorted to, and the precipitate (P) is in itself a valuable manure, and may, by the addition of acid, be converted into a high class superphosphate.

In cases in which it is difficult to obtain a market for (D) when (D) is alone produced, or when lime precipitation must be employed, and neither (D) nor (L) can be disposed of readily, I vary the mode of procedure. I then use lime alone for the deodorization of (D). My object now is to distil off the nitrogen as ammonia, and to use the residue as a precipitant for the effluent from (D). To enable this to be done I add a considerable quantity of lime to (D), and the ammonia distilled off I pass into an acid solution in the ordinary manner in order to fix it. The salt of ammonia thus obtained may be used to fortify the precipitate (P) or in any other manner. The carbonaceous residue after having been used in the precipitation of the effluent from (D) may be converted into a cement by a well known process, or it may be subjected to calcination to form a cement without further treatment as a precipitant, or again it may be employed as a deodorizer of fecal matters. I may also prepare a valuable substitute for animal charcoal by treating the dried deposit as bones are treated in the preparation of that material.

Having now described my Invention of improvements in the treatment of sewage and night soil, and having explained the manner of carrying the same into effect, I claim as the Invention secured to me by Letters Patent as aforesaid,—

First. The separation from raw town sewage of the greater portion of the liquid matters, and the subsequent treatment (as herein set forth) of the solid matters that are deposited therefrom, so that such solid matters may be more conveniently converted into fertilizing substances, as herein set forth.

Second. The removal by precipitation of the carbonic acid from the untreated effluent or liquid resulting from the above process, and reusing the precipitate so obtained, as and for the purpose herein set forth.

Third. Treating the effluent (after the precipitation therefrom of the carbonates, as herein set forth) by a second precipitation process in order that a precipitate may be obtained free from the grosser matters and the carbonic acid contained in the sewage.

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Fourth. Subjecting the precipitate obtained by this second precipitation to a process of distillation for the purpose of obtaining therefrom valuable products, such as charcoal and ammonia, as herein set forth.

In witness whereof, I, the said Henry Young Darracott Scott, have hereunto set my hand and seal, the Twelfth day of June, in the year of our Lord One thousand eight hundred and seventy-five.

HENRY Y. D. SCOTT. (L.S.)

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Printers to the Queen's most Excellent Majesty. 1875.